OUTLINES

OF A

COURSE

OF

Mechanical Philosophy.

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OF A

COURSE OF LECTURES

ON

Mechanical Philoſophy,

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INTRODUCTION.

ARTS—Sciences—Natural History—Philosophy.

Every change in the state of things is considered as an EFFECT, *indicating the agency, characterising the kind, and measuring the degree of its* CAUSE.

Necessary connection—Physical Law—Phenomenology—Aitiology—Theory.

Appearances of *Mind*——*Intellectual System*——*Supreme Mind*—*Natural Theology*.

Appearances of Matter—Material System—Natural Philosophy—Phenomena divided into Mechanical, Chemical, and Physiological.

MECHANICAL PHILOSOPHY *is the study of the sensible motions and actions of bodies, in order to discover the mechanical laws of nature, to explain subordinate phenomena, and to improve art.*

PART I.

SECT. I.

OF Motion—Space—Time—Direction—Velocity. The most convenient measure of velocity is the space uniformly described during a second of time; and may be thus expressed $v \doteq \frac{s}{t}$.—Its measure, when the velocity is continually changing, is $v \doteq \frac{\dot{s}}{t}$.—Composition of motion—Two uniform motions along the sides of a parallelogram compose an uniform motion along the diagonal—Equivalent motion—resulting motion—compound motion.—A *Change of Motion* is characterised and measured by that motion which, when compounded with the former motion, produces the new motion—Acceleration—retardation—deflection.—The measure of an observed acceleration or retardation is the change uniformly made during a second of time on the velocity, and may be expressed thus, $a \doteq \frac{\dot{v}}{t}$.

The measure of a deflection is the quotient arising from dividing the number expressing the square of the arch described during a second, by that chord of the equicurve circle which has the direction of the deflection; and it may be thus expressed $d \doteq \frac{v}{c}$.

SECT. II.

OF matter—Its distinguishing property—*Solidity*—does not arise from the contact of particles—Quantity of Matter—Density.

SECT. III.

OF mechanical action—powers—forces—impulse—pressure—attraction—repulsion—tendency—reaction—resistance—Mechanical philosophy, if properly cultivated, is a demonstrative science.

First law of motion. *Every body perseveres in a state of rest, or of uniform rectilineal motion, unless affected by some mechanical force.*

Second law of motion. *Every change of motion is proportional to, and has the direction of, the changing force.* Composition and resolution of forces—Equivalent or resulting force.

Accelerating, retarding, and deflecting forces, are specified and measured by the accelerations, retardations, or deflections, which are considered as their effects. It is very convenient to compare all or any of these with the acceleration, retardation, or deflection, produced by common terrestrial gravity. The weight of a body at the surface of the earth causes it to fall 16 feet and an inch (very nearly) in a second of time; and by thus acting on it uniformly during a second, it augments its perpendicular descent, or di-

minishes its perpendicular ascent, by this quantity; and it causes it to deflect as much from any line of motion. It also communicates an increment or decrement of velocity of 32 feet 2 inches *per* second. All accelerating, retarding, or deflecting, forces may be compared with this, either by comparing the spaces described or the velocities communicated.

Central forces—centripetal—centrifugal.

Of systems—centre of position—the motion of this centre, in consequence of external action, is not affected by the mutual, equal, and opposite actions of the bodies which compose the system.

PART

PART II.

Mechanical History of Nature.

SECT. I. ART. I.

Astronomy.

Phenomena of diurnal revolution—Fixed ſtars—planets—Method of aſcertaining their motions—Inſtruments and obſervations in a fixed obſervatory—Inſtruments and obſervations for travellers.

Apparent motions of the ſun and moon—year—month—Calendar.

Apparent motions of the planets.

Detection of the real motions.

Solar ſyſtem—Ptolemaic—Egyptian—Copernican—Tychonic—Semitychonic—Deciſion which of theſe is a juſt account of the celeſtial motions—Laws of Kepler.

1. The primary planets and comets deſcribe round the ſun, and the ſecondary planets deſcribe round their primary planets, areas proportional to the times.

2. The planets deſcribe ellipſes, having the ſun or primary planet in one of the foci.

3. The

3. The ſquares of the periodic times are proportional to the cubes of the mean diſtances.

Physical Astronomy.

The planets are retained in their orbits round the ſun by a force directed to the ſun, and inverſely proportional to the ſquare of the diſtances from him. The ſecondary planets are retained in their orbits round their reſpective primary planets by forces directed to them, and varying according to the ſame law. They are alſo made to accompany their primary planets by a force directed to the ſun, and varying according to the ſame law.

This force is mutual between the planets and the ſun, and between the ſecondary planets and their primaries.

The planets are alſo actuated by forces directed to each other, and varying according to the ſame law.

The force by which the moon is retained in her orbit round the earth, is nowiſe different from the weight or gravity of common terreſtrial matter. This is found to be directed, not to the centre of the earth, but to every part of it.

Hence it was juſtly inferred by the illuſtrious Sir Iſaac Newton, that every particle of matter *gravitates* to every particle of matter, with a force inverſely proportional to the ſquare of the diſtance—Quantity of matter in the ſun, and in ſome of the planets.

Theory of Phenomena—Elliptical motion of the planets—Diſturbances of the planetary motions—Lunar irregularities—Figure of the earth—Tides—Trade winds on the earth and on Jupiter.

ART. II.

PROJECTILES.

A HEAVY body, near the surface of the earth, falls with a motion which is uniformly accelerated. If projected directly upwards, it rises with a motion uniformly retarded. If projected in any other direction, it describes a parabola. Theory of gunnery.

This motion is so much affected by the resistance of the air, that the theory is scarcely of any use for directing the practice.

SECT. II.

IT is highly probable that the particles of tangible matter are not in contact, but are connected by mechanical forces, which, like gravity, act at a distance.

Theory of Father Boscovich—Limit of cohesion—of dissolution—solidity—elasticity—softness—want of elasticity—fluidity of liquids—of vapours.

Propagation of forces through the parts of solid bodies.

1. When

1. When three forces balance each other by the intervention of a ~~solid body, their directions are in~~ one plane; and their directions meet in one point.

2. Any two of them are inversely proportional to the perpendiculars drawn on their directions from the point to which the third is applied.

3. They are such as would balance if applied to one point.

4. When any number of forces are in equilibrio by the intervention of a solid body, they are such as would be in equilibrio if applied to one point.

Of the strength of Materials.

Of the strains to which they are exposed.

ART. I.

Mechanism of solid Bodies.

I. Production of motion in free space—1. When the direction of the force passes through the centre of position. —Quantity of Motion. If a body moves in any direction with the velocity *v*, without turning round, every particle moves in parallel lines with the same velocity. If *m* be the number of equal particles, the product of *m* and *v* (which we may express by the symbol *m v*) will properly express and measure the whole motion, considered as the aggregate of the motions of each particle; and it will express

prefs or meafure the force p which produces it. This may either be confidered as producing the velocity v in the number m of particles, or the velocity mv in one particle: And it may be confidered as the aggregate of the number m of accelerating forces, each of which would produce the velocity v in one particle.

In like manner, another motive force q may produce a velocity u in each particle of a body which contains n particles. Its meafure as a *vis motrix* is $n\,u$, and as an accelerating force it is u.

We have therefore $p : q = m\,v : n\,u$

and $v : u = \frac{p}{m} : \frac{q}{n}$; that is, the velocities which may be produced by different forces, are directly as the forces, and inverfely as the quantities of matter in the bodies to which they are applied.

2. When it does not pafs through the centre—combination of progreffive and rotatory motion—SPONTANEOUS AXIS OF CONVERSION—nutation of the earth's axis—preceffion of the equinoxes.—Rotation of the planets—whirling of fhot.

II. Change of motion by immoveable obftacles—penetration—of clay—of fand—reflection of cannon fhot from fuch bodies.

III. Change of motion by impulfe.—The motion of the common centre of pofition is not changed by collifion.—Laws of collifion of unelaftic bodies.—The bodies remain in contact after the ftroke; and the common velocity is had by dividing the fum or the difference (according as the bodies were moving in the fame or in oppofite directions) of the quantities of motion, by the fum of the quantities of matter.—Of elaftic bodies.—The change of motion produced by the collifion of perfectly elaftic bodies, is double of the change made in the motion of each, had they been unelaftic,

laſtic.—Meaſure of the degrees of elaſticity.—Communication and extinction of motion—Diſpute about the force of moving bodies—Conſervatio virium vivarum.

IV. Change of motion by conſtrained paths—motion round fixed points or axes—centre of percuſſion—centrifugal forces.

V. Solidity combined with gravity—centre of gravity—ſtability—ſliding—rolling—attitudes of animals—conſtruction of arches and domes—and roofs.

VI. Of pendulums—motion in a cycloid—as the circumference of a circle is to its diameter, ſo is the time of one vibration of a cycloidal pendulum to the time of falling through half its length—conical pendulum—meaſure of the accelerative power of gravity—variation of gravity in different parts of the earth—regulation of clocks—centre of oſcillation.

ART. II.

Theory of Machines.

Imperfect ſtate of this theory—falſe maxim adopted—leading queſtions—1ſt, What is the proportion of the preſſures excited in the different parts of the machine?—2d, What will be the motion of a machine, urged by a given force, and overcoming a given reſiſtance?

Queſtion 1ſt, Mechanical powers—a mechanical power is ſome piece or aſſemblage of cohering matter, interpoſed between the preſſure employed as a power, and the preſſure ariſing from the reſiſtance oppoſed by the work which is to

be

be performed, in ſuch a manner that, by means of the connecting corpuſcular forces, and the reaction of the interpoſed matter of the points of ſupport, the preſſure exerted on the IMPELLED POINT of the mechanic power excites a preſſure or force at the WORKING POINT equal to the reſiſtance actually oppoſed by the work.

The ENERGY of the mechanic power is properly expreſſed by the quotient of the reſiſtance, divided by the power.

In the SWIG, the power, or preſſure exerted at the empelled point, is to the reſiſtance, or preſſure excited at the working point, as the perpendicular drawn from the fixed point on the direction of the reſiſtance to the perpendicular drawn from the fixed point on the direction of the power: Or, they are reciprocally as the perpendiculars drawn from the fixed point on the lines of their direction.

Let p and r expreſs the power and the reſiſtance; and let m and n be the perpendiculars on the lines of their direction, we have $p : r = n : m$, and $p m = r n$.

Suppoſing the power to remain the ſame, as alſo the perpendicular n. It is plain, that if we increaſe m, we may increaſe r in the ſame proportion. Therefore the product of p and m, that is, $p m$, will expreſs the mechanical effort, eneryg, or momentum, of the power acting at the diſtance m. In like manner $r n$ expreſſes the momentum of the reſiſtance.

In the LEVER, the power and reſiſtance are reciprocally proportional to the perpendiculars drawnfrom the fulcrum on the directions.

The preſſure on the fulcrum is the ſame as if the power and reſiſtance were applied there, each in its own direction.

The WHEEL AND AXLE, or windlas, is a perpetual lever.

In the PULLEY, the power is to the reſiſtance as unity to the

the number of parallel ropes by which the resistance is withstood.

In the INCLINED PLANE, where the motion of a body along the plane is resisted in a direction perpendicular to the base, the power is to the resistance as the height of the plane is to its length.

In the WEDGE, the power is to the resistance perpendicular to the side of the wedge, as half the base is to the side.

The SCREW is a wedge wrapped round a cylinder.

General theorem. In any mechanic power, the power and resistance are reciprocally proportioned to the velocities of the impelled and working-points, estimated in the directions in which the power and resistance are exerted.

When the energy of one mechanic power is employed as a moving power acting on the impelled point of another, of the same or of a different kind, we have a COMPOUND MACHINE: Its energy is expressed by the product of the energies of each simple mechanic power.

Maxims of construction—difficulty of preserving the same energy and the same porportion of motion of the impelled and working-points in the different positions of the machine—form of the teeth of wheels for this purpose—disadvantages of irregularity—advantages of simplicity.

Of FRICTION—cause of the diminution of the performance of machines by friction—some measures of this diminution.

Diminution of performance by the inertia of the machine.

Some observations on the mechanism of animal bodies—muscular motion and action. Muscles are parallel, radial, pinnated, or sphinctres.

Question 2d, Momentum of impulse —— momentum of effect—causes which prevent the continual acceleration of machines

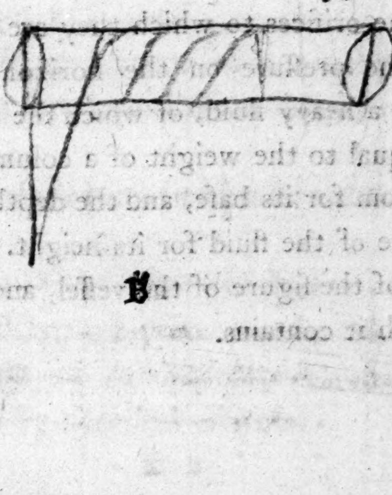
machines—changes produced in the preſſure of the impelling power and reſiſtance by the motion of the impelled and working points—erroneous maxims—important propoſitions.

Prop. 1ſt, When a machine has acquired an uniform motion, the momenta of impulſe and of effect are equal—Regulating and accumulating power of a FLY—or of a conical pendulum.

Let f be the preſſure which the impelling force exerts on the machine at reſt. Let p be the preſſure which it exerts on the impelled point moving with the velocity m. Let c be that velocity of the impelled point which annihilates the preſſure of the impelling force. Let v be made equal to $c-m$; ſo as to expreſs what may be termed the relative velocity. Let it be diſcovered, by experiment, that the preſſure exerted by the impelling force varies in the proportion of v^q.

Prop. 2d, The performance of a machine is the greateſt when $m = \frac{c}{q+1}$

Maxims for the conſtruction of machines.



ART.

A R T. III.

Of the Mechanism of fluids.

A fluid body is ſuch whoſe parts yield to the ſmalleſt impreſſion, and, by yielding, are eaſily moved among themſelves.

Imperfect fluidity—viſcidity—fluidity the effect of fire—miſtakes about the formal cauſe of fluidity.

All fluids compreſſible—Florentine experiments—Canton's more ſimple experiments—diviſion of the ſubject—hydroſtatics—pneumatics.

Hydrostatics.

Prop. 1ſt, If a fluid without weight be contained in any veſſel having two orifices, to which are applied two external forces, an equilibrium will obtain, if the forces are in the proportion of the orifices to which they are applied.

Prop. 2d, The preſſure on the horizontal bottom of a veſſel filled with a heavy fluid, of which the upper ſurface is horizontal, is equal to the weight of a column of that fluid, having the bottom for its baſe, and the depth of the bottom under the ſurface of the fluid for its height. This preſſure is independent of the figure of the veſſel, and of the quantity of fluid which it contains.

Prop.

Prop. 3d, Any surface immersed in a heavy fluid, of which the upper surface is horizontal, is perpendicularly pressed with a force equal to the weight of a column of that fluid, having the surface pressed for its base, and the depth of its centre under the surface of the fluid for its height.

Prop. 4th, The *vertical* pressure on any surface immersed in a heavy fluid, having a horizontal surface, is equal to the weight of the *vertical* column which may be incumbent on that surface.

Cor. 1st, The force requisite for supporting a vessel containing a heavy fluid is equal to the weight of the vessel and fluid.

Cor. 2d, The horizontal pressures on the opposite sides of the vessel are equal and opposite.

Prop. 5th, The upper surface of a homogeneous heavy fluid in any vessel, or system of communicating vessels, is horizontal.

Conducting of water—Levelling.

Prop. 6th, If different heavy fluids, which do not mix, are contained in a vessel, their separating surfaces are horizontal, and the heaviest will occupy the lower place.

Practical inferences—Pressure of water on a square foot is $62\frac{1}{2}$ lbs. for every foot in height—strength of dams—banks—dock-gates—pipes.

Prop. 7th, A solid immersed in a heavy fluid is pressed upwards with a force equal to the weight of the fluid which it displaces.

Mechanism of floating bodies—Burthen and stability of ships.

Investigation of the density of bodies—Specific gravity—Hydrostatic balance—Hydrometer for spirits—Bubbles for spirits—Problem of Archimedes—Cautions—Change of specific gravity by chemical mixture.

Hydraulics.

Treats of the motion and impulse of fluids—The theory of these motions is very imperfect. It is usually received as a fundamental proposition, that

A fluid impelled by its weight alone, issues from any orifice with the velocity which a heavy body would acquire by falling from the surface of the fluid to the orifice.

Many circumstances, of which the effect is not understood, cause the velocity to differ greatly from that now assumed.

Of the motion of fluids impelled by pistons—circumstances of great consequence in the construction of machines for this purpose.

Of the impulse and resistance of fluids—very imperfectly known.

Of hydraulic machines—Overshot wheels—Undershot wheels—Parent's mill—Motion and working of ships.

Pneumatics.

Air—proofs of its materiality—of its weight—specific gravity—pressure arising from the weight of air—it is equal to near 15 lbs. on a square inch—rise of water in pumps and syphons—Toricellian experiment—Barometer—method of determining the height of mountains.

Compressibility of air—Condensing syringe—Exhausting syringe—Air-pumps—Smeaton's—The elasticity of air is nearly proportional to its density—Sea-gage—Height of the atmosphere—Correct method for determining the height of mountains by the barometer—Connection between the

height

height of the Mercury in the barometer and the ſtate of the weather.

Explanation of natural phenomena—Suction—Animal breathing—Air-bladder of fiſhes—Drawing of chimneys—Cauſes of ſmoking vents—Cures—Reciprocrating ſprings.

Pneumatic machines—Bellows—Water blaſt—Wind gun—Diving bell—Pumps—Sucking pumps—Forcing pumps—Air barrel—Important maxims—Hungarian machine.

Undulation of air—Sound—Production of Sound—Muſical ſound and pitch—Muſical inſtruments—Theory of muſic.

Boiling of fluids—Steam engine—Savary's—Newcomen's—Watt's.

Action of inflamed gunpowder—Theory of fire-arms and artillery.

SECT. III.

Magnetism.

Leading facts. 1ſt, Any oblong piece of iron, at liberty to move, will arrange itſelf in a certain determinate poſition with reſpect to the axis of the earth.

2d. Any ſuch piece of iron attracts, and is attracted by, another ſimilar piece.

Difference between common iron and magnets or loadſtones. The magnetiſm of the latter is determinate and permanent; that of the former is indifferent and tranſitory.

Leading facts in magnets or loadſtones. 1ſt, A magnet arranges itſelf in a determinate poſition—poles.

2d, The diſſimilar poles of two magnets attract each other, and their ſimilar poles repel each other.

Law of magnetic attraction and repulſion—It may be expreſſed by the ordinates of an aſymptotic curve, every where convex towards its abſciſſa.

Variation of the compaſs—Change of this variation—dip of the mariner's needle.

Theory of the mutual action of magnets——Magnets, placed with their diſſimilar poles fronting each other, are mutually attracted—if their ſimilar poles front each other, they are mutually repelled, except at very ſmall diſtances in ſome caſes—This action is increaſed, by increaſing the force

force of one or both—by diminiſhing the diſtance between them—and by increaſing the length of one or both.

A magnet B, in the neighbourhood of another magnet A, arranges itſelf in a determinate poſition—polarity of B—directive power of A—theſe are increaſed by increaſing the power of either——by diminiſhing their diſtance—by increaſing the length of A——by diminiſhing the length of B —— A magnet may exert a great directive power on another magnet, while its attractive power may be inſenſible.

The magnetiſm of magnets is, in ſome degree, tranſitory—ſooneſt acquired and loſt by ſoft ſteel—moſt ſlowly by hard ſteel and loadſtones—Various ways in which it is acquired and loſt—moſt remarkably by vicinity to magnets.

Theory of the mutual action of magnets and iron—Any piece of iron becomes a magnet by ſimple juxtapoſition to a magnet, and its poles have a determinate poſition with reſpect to the poles of the magnet employed—Magnetiſm by induction—This is the reaſon why a piece of iron is always, and in every ſituation, attracted by a magnet—It is alſo the cauſe of that curious arrangement of iron-filings ſtrewed round a magnet, which has given riſe to the uſually received, but falſe, theories of magnetiſm.

Directions for making artificial magnets—Antheaume's method—Method of Mitchel and Canton.

Dr Gilbert's theory of magnetiſm—The earth is a great magnet—The action of this magnet is the cauſe of all the phenomena of magnetiſm, both natural and artificial—This theory abundantly confirmed by experiment—Explanation of the change of the poſition of the mariner's needle.

Hypothesis of Æpinus.

Magnetical fluid—its particles repel each other, but attract the particles of some ingredient in iron, with a force decreasing with an increase of distance—The particles of this ingredient in iron repel each other in the same manner—The magnetical fluid is moveable—with great difficulty in the pores of hard steel and loadstones—more easily in the pores of soft steel and iron—Overcharged pole—Undercharged pole—Neutral point—This hypothesis very agreeable to all the phenomena.

E C T IV.

Electricity.

A body is said to be electrical or electrified when it attracts, and, after contact, repels another body—Various sources of this quality—friction—change of temperature—change of state in fusion, congelation, evaporation, condensation, solution, precipitation, animal and vegetable powers—*Electricity by excitation*—*Excited electricity*—*Electrics*—*Non-electrics*.

Any body B, brought into the neighbourhood of an electrical body A, becomes electrical—*Induced electricity*—*Electricity by position*—In this manner the operation of the cause of electrical phenomena may be said to be propagated through bodies—*Conductors*—*Non-conductors*—a body rendered electrical by position is always attracted—perfect similarity

milarity between the phenomena of induced magnetiſm and induced electricity.

If B be brought very near to A, a ſpark is obſerved between them, B becomes permanently electrical, and the electricity of A is diminiſhed—*imparted* or *communicated electricity*—A body rendered electrical by communication is always repelled—Electrometer—In order that a body may exhibit appearances of electricity it muſt be ſurrounded by non-conductors—*Inſulation.*

Electrical machine—Electric—Rubber—Prime conductor.

Hypotheſis of Dr FRANKLIN, *improved by* ÆPINUS.

Similar to his magnetical hypotheſis—Electrical fluid—proofs of its exiſtence—law of action ſimilar to the law of the magnetical fluid—Action inverſely as the ſquare of the diſtance.

Application of this Hypotheſis.

Undercharged body—Overcharged body—undercharged part—overcharged part—State of neutrality—*Excitation by friction*—When two bodies are rubbed together, one of them becomes overcharged, and the other becomes undercharged—*Plus*—*Minus*—*Poſitive electricity*—*Negative electricity*—Circumſtances which promote the emiſſion or abſorption—Electroſcope—Maxims for conſtructing electrical machines.

Theory of induced electricity—Theory of the electrophorus.

Theory of communicated electricity—Diſtribution of the electrical fluid—Redundant fluid and redundant matter more nearly proportioned to the ſurface than to the quantity of matter—Tendency to eſcape from points and edges—Cauſe of the obſerved ſtream of electrified air—Pencil of light—Star—Electrical ſpark and ſnap—Vivacity depends on the

quantity

quantity of fluid transferred—Method of producing a great accumulation by induction—Theory of coated glass, or of the Leyden phial—the accumulation is chiefly in the glass itself—Electrical shock.

Miscellaneous experiments, exhibiting the most remarkable effects of the electrical fluid—Medical electricity.

Theory of thunder and lightning—protection from its dangerous effects—Of earthquakes—Aurora Borealis.

SECT. V.

Optics.

Medium of vision—why thought necessary—proofs of its existence—phosphori—light of diamonds—effects of illumination on plants and minerals—Light—materiality of—its mechanical nature to be inferred from the phenomena.

LAW I.

Light, or the cause of vision, moves uniformly in straight lines at the rate of about 200,000 miles in a second—Aberration of the heavenly bodies.

Radiant point—Beam of light—Ray—Pencil—Convergent—Divergent—Focus, real and virtual—Image, real and virtual.

Intensity of light in a beam and pencil—Brightness—Interception of light.

Illumination—shadow—penumbra—Camera obscura of Battista

Battista Porta—Visibility of bodies—Shining bodies—Illuminated bodies—Reflection of light—Reflecting plane—plane of reflection—Angle of incidence and of reflection.

LAW II.

The angles of incidence and reflection are equal.

Catoptrics—Theory of mirrors—plane—spherical—cylindrical, &c.—Aberration.

Transparent bodies are called Media—When light passes obliquely through the surface which separates two media, its direction is changed, and the light is said to be *refracted*.

LAW III.

The sine of the angle of incidence is to the sine of the angle of refraction in a constant ratio.

Dioptrics—Refractive power different in different bodies—Refraction through several media—through the atmosphere—Reflection from the posterior surface of transparent bodies—Brilliancy of jewels—of dew drops—Theory of refraction through plane and spherical surfaces—through glasses—lense—convex—concave—plano-convex and concave—double convex and concave—Meniscus.

Of the eye—description of the eye—progress of light through the eye—formation of the picture at the bottom—connection of this with vision—seat of vision—defects of vision, and remedies—Curious and important facts.

Of the ideas acquired by sight—direction of objects—relative situation—objects are seen erect by means of inverted pictures—magnitude of objects—figure—distance—Errors of judgment in these circumstances—Perspective, lineal

lineal and aërial—horizontal moon—Brightneſs of objects—ſingle viſion—double viſion—ſquinting.

Viſion by means of mirrors and glaſſes—Apparent magnitude and diſtance—Field of viſion—brightneſs.

Optical inſtruments. Firſt claſs: Camera obſcura—Magic lanthorn—Solar microſcope—Helioſcope—Burning mirrors and lenſes.——Second claſs: Microſcopes—ſimple—compound—Teleſcopes—Galilean—aſtronomical—day teleſcope—Dollond's eye-piece—Reflecting teleſcope—Newtonian—Gregorian—General defects of optical inſtruments.

Of colour—*The perception of colour is the effect of a property inherent in the rays of light, by which each kind is fitted for invariably exciting the ſenſation of a particular colour*—This quality not produced or changed by any reflection or refraction—Homogeneous light—Heterogeneous light—The perception of whiteneſs is the effect of the combined action of all the heterogeneous rays, illuminating the ſame ſurface, or falling on the ſame part of the eye—Whiteneſs of ſnow, froth, paper, pounded glaſs, &c.—Primitive colours—All others ariſe from a mixture of theſe—The colours of natural bodies ariſe from their quality of reflecting or tranſmitting more copiouſly the rays which excite the ſenſations of thoſe colours.

LAW IV.

The rays of different colours have different degrees of refrangibility, in the following order; red, orange, yellow, green, blue, purple, violet; the violet rays being moſt refracted—*Diſperſion of light*—Bodies differ in their diſperſive, as well as in their refractive, powers.

LAW

LAW V.

THOSE rays which are moſt refrangible are alſo moſt reflexible from the poſterior ſurface of tranſparent bodies.

LAW VI.

IF a tranſparent plate has leſs than a certain determinate thickneſs, no light is reflected, the whole paſſing through. This thickneſs is different in different ſubſtances, for differently coloured rays, and for different angles of incidence.

LAW VII.

WHEN homogeneous light falls on a tranſparent plate, of which the thickneſs is 1, 3, 5, 7, &c. it is reflected;—but if the thickneſs be 2, 4, 6, 8, &c. it is tranſmitted.

Explanation of the coloured rings obſerved on the top of a ſoap-bubble, or between the object glaſſes of long teleſcopes.—The rays of light are alternately in ſituations which are favourable to reflection or to tranſmiſſion.—Theſe fits of eaſy reflection and tranſmiſſion recur at equal intervals of ſpace and time.

LAW VIII.

WHEN light paſſes by any body, at certain very ſmall diſtances, it is alternately inflected and deflected—Light is acted on by bodies at a diſtance.

Explanation of the rainbow, halo, and parhelion.

Explanation of the colours of natural bodies—thoſe

tranſparent

tranſparent bodies reflect light moſt copiouſly which have the greateſt refracting power—The ſmall parts of almoſt all bodies are tranſparent—Opacity ariſes from the interſperſion of tranſparent particles having different refracting powers—the colours of bodies ariſe from the thickneſs of their tranſparent particles—theſe thickneſſes may be diſcovered by means of the colour.—Light is not reflected by impact on the ſolid matter of bodies.

Application of theſe doctrines to the improvement of optical inſtruments—Great defect of refracting inſtruments—Achromatic teleſcopes.

Inferences from the optical laws, tending to explain the mechanical nature of light.

The moſt obvious and moſt general opinion is, that light is a ſtream of matter emitted from the ſhining body—many difficulties attend this opinion—Theory of Deſcartes—Huyghens imagines that light is an elaſtic fluid, and that the optical phenomena are the effects of the undulation of this fluid, as ſound is the effect of the undulations of air—Euler ſuppoſes that the optical phenomena are the effects of the undulation of æther—His explanation of the motion of light—colorific differences of undulations—reflection—viſibility of objects—refraction. This theory is hypothetical, and the application of the hypotheſis is incompatible with the eſtabliſhed principles of mechanical philoſophy.

Arguments which ſupport the common opinion concerning the nature of light—proofs of its materiality—chemical effects—it ſeems to be the ſource of the green fæcula, and of the aromatic oil of plants—it is imbibed and emitted by many bodies—phoſphori—diamonds—ſpars.

The

The common opinion explains, in perfect consistency with mechanical laws, all the phenomena of illumination, reflection, refraction, and inflection—removal of the chief difficulties which attend this opinion—Mr Wilson's experiment for deciding the question—Conclusion.

FINIS.